

The present invention relates to a changing device for a machine tool with a magazine for removing a tool or work-piece from the magazine and for transportation thereof into the machine tool or for the removal thereof from the machine tool and for transportation thereof into the magazine, the magazine comprising a plurality of substantially disc-shaped tool or work-piece supports arranged coaxially and able to rotate about a first shaft, along the periphery of which supports the tools or work-pieces are received, a transportation arm being provided, which is mounted to tilt about a second shaft at a distance from the first shaft, is vertically adjustable along the second shaft, is adjustable in its length and is provided with a gripping member, and the transportation arm being provided with a swivel joint, whereof the axis of rotation extends at an angle of 45° with respect to the longitudinal adjusting direction of the transportation arm.

In some machining operations on one and the same work-piece, it is necessary in the course of machining to repeatedly change the tool used by the machining device, in particular, if the control of the machining device takes place more or less automatically and thus is capable of carrying out a plurality of successive machining operations on one and the same work-piece. In order not to disturb or interrupt this machining process taking place automatically, automatically operating tool-changing devices have been created, which if necessary may also be controlled by the machine programme.

These problems occur to a particular extent in the spark machining of work-pieces, since this is a machining process which proceeds relatively slowly, thus increasing the endeavour to automate the process. Thus, for example, in spark machining devices, electrode changing devices are known, in which an electrode magazine constructed in the manner of a chain and rotating endlessly is provided.

A gripper arm has the task of gripping a selected electrode and inserting it in the machining device or removing it from the machining device and returning it to the magazine. At the time of removal from the magazine, in order that the correct electrode is picked up, or at the time when it is deposited in the magazine, in order that the electrode once more assumes its predetermined place, a revolving magazine of this type must be driven until the selected electrode or the predetermined storage space is located in the region of the gripping arm.

The drawback of electrode changing devices of this type is on the one hand the great space requirement and on the other hand the relatively great access time, particularly if a large number of electrodes are stored in the magazine and should be available for random access. In order to avoid these drawbacks it has been proposed to construct the tool magazine with a plurality of substantially disc-shaped tool supports, which are able to rotate about a first shaft, along the periphery of which supports the tools are located and to provide a transportation arm, which is able to tilt about a second shaft located at a distance therefrom, in order to engage the tools, to remove them from the magazine and insert them in the machining device or vice versa.

A device of this type has a substantially shorter access time and a reduced space requirement.

However, it is a drawback that such a device cannot be used universally. Firstly, modern machining centres, with enclosed spark machining devices, frequently operate with several reference axes, i.e. an electrode or a work-piece must be clamped either vertically or horizontally; on the other hand, the case also occurs that a plurality of work-pieces is to be machined in succession with a single tool, which is not to be exchanged, for example

with a single electrode. The requirement can be derived from this that an apparatus of the aforementioned general type should be universal so that on the one hand it is capable of inserting tools into the machining device along several reference axes, but on the other hand should also be used for changing work-pieces.

It is the object of the present invention, based on the prior art, as it is described for example in the paper "Flexible Drehzelle mit automatisierten Palettiersystem" "Flexible rotary cell with automated palettization system" (VDI - Zeitschrift Band 125, No.3, Februar 1983, Seiten 71-73) (German Engineering Union Journal, Volume 125 No. 3, February 1983, Pages 71 to 73) and as defined in the preamble of Patent Claim 1, to provide an improvement which is capable of fulfilling the aforementioned requirements, namely, with a compact construction and short access time, in the case of virtually any machining devices, to change both tools with a horizontal or vertical reference axis as well as work-pieces, which are clamped in the horizontal or vertical direction.

This object is achieved by the measures described in the characterising part of Claim 1. Developments of the invention are disclosed in the dependent Claims 2 and 3.

Due to the design of the support arm provided according to the invention, a freedom in the movement of the gripping member results in a surprisingly simple manner, which freedom was previously unknown in such devices. Thus the universal application of the magazine changer unit is guaranteed, since the gripping member has access even to narrow, inaccessible places and it is purely a matter of adapting the control to use the device constructed according to the invention together with a plurality of machining devices.

In particular the following advantage results from the construction according to the invention:

If namely the length of the two legs or the curvature of the support arm member is dimensioned so that a straight line passing through the axis of rotation of the swivel joint extends through a centre point of the gripping member, at which the central axis of a tool or work-piece received by the gripping member is located, due to a 180° rotation of the swivel joint, tilting of the tool or of the work-piece through 90° without actual displacement, through a fixed tilting point, can be achieved. This simplifies the control to a critical extent.

One embodiment of the device according to the invention will be described in detail hereafter with reference to the accompanying drawings. It should be pointed out that in the following description, given by way of example, for the sake of simplicity, the device is described in conjunction with an electroerosion machine; however it should be understood that the range of use is in no way restricted to erosion machines of the type illustrated; on the contrary, an advantageous use with a plurality of machining devices is conceivable, in which tools and/or work-pieces are to be changed automatically.

In the accompanying drawings:

Figure 1 is a diagrammatic view of an electroerosion machine and a magazine changer unit from the front;

Figure 2 is a diagrammatic view of the electroerosion machine and of the magazine changer unit according to Figure 1 from the side, in the direction of arrow II of Figure 1; and

Figure 3 is a diagrammatic view of the electroerosion machine and of the magazine changer unit according to Figure 1 from above.

In the drawings, the reference numeral 1 generally illustrates an electroerosion machine and the reference numeral 2 a magazine changer unit. The erosion machine comprises a base 3, on which a table 4 able to move in the X- and Y-direction is mounted. The table 4 supports a trough 5 open on the upper side, which serves to receive the liquid necessary for the erosion process. Also located on the base 3 is an upright 6, which supports the machine head 7. In the machine head 7 a sleeve 8 is received in the Z direction, i.e. is vertically adjustable and possibly able to rotate. The sleeve 8 is provided with a chuck 9 for receiving a machining tool 10 shown only diagrammatically, namely an erosion electrode. A work-piece holder 11 is located in the trough 5, which holder receives a work-piece 12 to be machined.

The more accurate construction and method of operation of such an erosion machine is known to a man skilled in the art and does not need to be described in detail here.

The magazine changer unit 2 comprises a base frame 14, which serves as a base for a magazine and a transportation arm. The magazine comprises an upright column 15, which is able to rotate and receives a number of disc-shaped tool supports 16 arranged at a distance apart. Along the periphery of the disc-shaped tool supports 16, the tools 10 shown solely diagrammatically are located, for example they are inserted in peripheral slots in the tool supports 16.

The base frame 14 also receives a support column 17 located at a distance from the magazine column 15, for a transportation arm designated generally by the reference numeral 18. The support column 17 comprises a carriage 19, which is able to move along the column 17, for example by means of a pneumatic cylinder 20. The actual transportation arm 18 comprises three arm parts: a fixed arm part

21, which is attached to the carriage 19, a first telescopically slideable arm part 22 and a second telescopically slideable arm part 23. The mutual sliding of the arm parts 22 and 23 with respect to the arm part 21 may take place by a pneumatic cylinder located in the arm part 22, of which only the piston rod 24 can be seen in Figure 3.

Located at the free end of the second telescopically slideable arm part 23 is a swivel joint 25, to which a support arm member 26 is attached. In the example, the support arm member 26 comprises two legs 27 and 28, which are arranged at right angles to each other, the leg 28 not connected to the swivel joint 25 supporting at its free end a gripper member 29 for gripping a tool or work-piece.

The swivel joint comprises a joint axis X, which extends at an angle of 45° with respect to the longitudinal extent of the support arm parts 22 and 23. The leg 27 and thus the entire support arm member 26 together with the gripping member 29 can be rotated about this axis X. As shown in broken line in Figure 1 (the carriage 19 has thus been lowered somewhat), in a first rotary position, the leg 27 extends vertically and the leg 28 horizontally, whereas after a rotation of the swivel joint 25 through 180° , in a second rotary position, the leg 27 extends horizontally and the leg 28 vertically. The length of the legs 27 and 28 is preferably dimensioned so that the extended axis of rotation X extends through a centre point of the gripping member 29; the central axis of a tool or work-piece supported by the gripping member 29 is located at this centre point. It is thus ensured that as can be seen clearly from Figure 1 in the illustration in broken line, that centre point always remains at exactly the same place both in the first as well as in the second rotary position of the swivel joint 25.

Another possibility, which is not shown in the drawings, consists of constructing the support arm member 26 in a curved manner, in which case the curvature would likewise be dimensioned so that the extension of the axis of rotation X extends through the aforementioned centre point of the gripping member 29; the desired effect would also be reproduced here.

The function of the device is known per se: in the retracted state, as illustrated in broken line in Figure 3, the support arm 18 is tilted towards the magazine and the carriage 19 is moved along the column 17 into such a height that the gripping member 29 is at the height of the desired tool support 16. Then the arm 18 is extended somewhat, the tool 10 is gripped, the arm 18 is drawn back somewhat and then tilted into the position illustrated in full line in Figure 3, in order, after the completed extension of the arm parts 22 and 23, to bring the tool engaged by the gripping member 29 to the machining device. According to where the engaged tool or a work-piece possibly engaged is to be introduced, the vertical position of the carriage 19 is varied.

In any case it is essential that the support arm member 26 has a shape varying from that of a straight line, namely an angular or curved shape. As can be seen clearly from Figure 1, the support arm member 26 may thus be moved past the machine head 7 in a first, raised position (shown in full line), in order, by means of the gripping member 29, to insert a tool 10 in the chuck 9 of the sleeve 8. Likewise it is however also possible to introduce the gripping member 29 into the trough 5 (illustration in broken line), in order to deposit a work-piece 12 on the work-piece holder 11.

According to the work-piece, it may be necessary that the gripping member 29 acts from above or from the

side. This can be achieved by simple rotation of the swivel joint 25 through 180° , on the one hand it being ensured that the centre point of the gripping member 29 does not shift, and on the other hand that one can once more dip into the trough 5.

The device according to the invention can thus be used very universally and can be adapted to numerous machining machines. This is particularly the case if the tool magazine and the tool changing device or the work-piece magazine and the work-piece changing device together with an associated control device form a compact, physical unit, which, as shown in the drawings, can be located simply beside a machining device. A major part of the control, namely the movement of the transportation arm 18 with reference to the magazine, remains unchanged; solely that part of the control, which relates to the movement of the transportation arm 18 with reference to the machining device, must be adapted from case to case.



Claims

1. Changing device for a machine tool (1) with a magazine for removing a tool (10) or work-piece (12) from the magazine and for transportation thereof (10, 12) into the machine tool (1) or for the removal thereof (10, 12) from the machine tool (1) and for transportation thereof (10, 12) into the magazine, the magazine comprising a plurality of substantially disc-shaped tool or work-piece supports (16) arranged coaxially and able to rotate about a first shaft (15), along the periphery of which supports the tools (10) or work-pieces (12) are received, a transportation arm (18) being provided, which is mounted to tilt about a second shaft (17) at a distance from the first shaft (15), is vertically adjustable along the second shaft, is adjustable in its length and is provided with a gripping member (29), and the transportation arm (18) being provided with a swivel joint (25), whereof the axis of rotation (X) extends at an angle of 45° with respect to the longitudinal adjusting direction of the transportation arm (18), characterised in that a bent or curved support arm member (26) is provided, which at one end is connected to the swivel joint (25) and at the other end supports the gripping member (29), the dimensions and the bend or curvature of the support arm member (26) being proportioned so that a straight line passing through the axis of rotation (X) of the swivel joint (25) extends through a centre point of the gripping member (29), at which the central axis of a tool (10) or work-piece (12) received by the gripping member (29) is located.

2. Changing device according to Patent Claim 1, characterised in that the support arm member (26) is constructed to be L-shaped.

3. Changing device according to Patent Claim 2, charac-



terised in that the two legs (27, 28) of the L-shaped support arm member (26) enclose a right angle.